

Geriatric Psittacine Medicine

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KEYWORDS

• Aging • Arthritis • Atherosclerosis • Cataracts • Neoplasia

Geriatric is defined as “related to old age.” The determination that a bird is geriatric should therefore be based on knowledge of the average life expectancy of that species. Few psittacine species have been raised in captivity in significant numbers and subsequently reached geriatric status to determine at what age geriatric changes begin to occur. A preliminary table of ages for psittacine species at which they are considered geriatric has been developed, but it is anecdotal.¹ In addition, nutrition, genetics, and exercise are all major factors that can either expedite or delay changes related to aging. For purposes of discussion, geriatric is defined as the age at which medical conditions associated with aging in other species are currently being reported in psittacines.

In addition to overt disease, issues in geriatric patients include preservation of functional ability/mobility, recognizing and providing supplemental care needs, and quality of life concerns.

EVIDENCE-BASED MEDICINE

The term “evidence-based medicine” (EBM) has come into common usage in veterinary medicine, and is often used incorrectly. The consequence of this is hesitancy on the part of some veterinarians to attempt treatment when there are no controlled studies published on a given condition. If treatment is attempted, there may be concern that sharing the outcome with colleagues may lead to liability or ridicule.

The term “evidence-based medicine” is borrowed from human medicine, in which it is applied to the individual practitioner and to entire health care systems. It involves the analysis of existing data, including the critical statistical analysis of the validity of those data, as they relate to a particular treatment of a disease in a given population. As further defined by the Centre for Evidence-based Medicine, “Evidence-based medicine is the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients.”² Randomized, double-blind, placebo-controlled trials involving a homogeneous patient population and medical condition are the most reliable in establishing risk versus benefit ratios and recommendations

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for patient care. However, this information is not readily available in veterinary medicine, much less in specific species of exotics.

The principles of EBM do not suggest that treatment options should not be offered in the absence of a high level of confidence in the efficacy of a drug or treatment protocol. On the contrary, the principles state that when scientific evidence is lacking, of poor quality, or conflicting, such that the risk versus benefit balance cannot be assessed, clinicians should help patients understand the uncertainty surrounding the clinical service or treatment.

Veterinarians, especially in avian medicine, seldom have the support of controlled studies in any treatment of disease conditions. A few simple guidelines should allow exploration of treatment modalities for avian patients without concern for legal ramifications or derision from colleagues. Veterinarians must be:

1. Hesitant to extrapolate from other species when a drug or treatment carries significant risk of negative side effects
2. Cognizant that in clinical practice, concurrent changes (eg, improved diet and husbandry) and tincture of time may simulate efficacy for a given treatment
3. With the owners' informed consent, willing to treat avian patients with medication and other procedures for which there is no documented species-specific efficacy or safety, when not to treat presents a greater risk, "in our best conscientious, explicit and judicious interpretation of current best evidence."

Numerous medications have been discovered inadvertently, and the method of action of many others is still unknown. A lack of research does not indicate a treatment is ineffective, only that its effectiveness is not known. Veterinarians should share their anecdotal findings (positive and negative) honestly with other veterinarians. EBM is dependent on these initial anecdotal observations for direction.³

WHY GERIATRIC PSITTACINES ARE ATYPICAL

The life expectancies of birds are considerably longer than those of comparably sized mammals. This fact is of research interest and relevant to veterinary care for geriatric psittacine patients.⁴

Models for Human Aging

The metabolic process in all animals produces free radicals that can damage DNA. Therefore, it is counterintuitive that birds with high metabolic rates have some of the slowest rates of senescence. Poultry and caged birds are increasingly being used as models for the study of cellular damage, including degenerative neurobiology. For instance, the enzyme telomerase allows for replacement of short pieces of DNA known as telomeres, which are otherwise lost when a cell divides. Telomerase is considered an antiaging enzyme, preventing the degradation of cell chromosomes by allowing the replacement of terminal DNA. The expression of telomerase is downregulated with age in humans. This downregulation is believed to serve as protection against neoplasia, because high telomerase activity is associated with neoplastic processes. However, in 4 species of long-lived birds tested, telomerase activity was maintained throughout the lifespan of the birds, with the longest-living birds (storm petrels) having the highest telomerase activity in most tissues tested.⁵

Although the overall incidence of neoplasia increases with age in the bird species for which there are data (poultry and quail), discrepancies between the incidences of different neoplasias in older birds may elucidate the role telomerase plays in certain types of cancer.⁶

Senility/Dementia

The effects of aging on bird cognition are unknown. Some studies have noted the effects of captivity on the hippocampus volume in birds, demonstrating that the volume is reduced in captivity, with an associated decrease in particular types of memory.⁷ Cellular studies of human memory loss with aging and in human Alzheimer disease have been conducted using various avian tissues. For instance, the amyloid precursor protein (APP) is implicated in age-associated changes at synapses that contribute to memory loss in Alzheimer disease. Human and avian APP share 95% homology in amino acid sequence, and gallinaceous chicks are being used to study this protein.⁸

No controlled studies of “senility” in birds have been reported. A few anecdotal accounts from veterinarians and owners of older birds suggest that senility may occur. These reports include older birds’ inability to locate entrances to cages and food sources, with which they were previously familiar, in the absence of detectable vision loss. Behavioral changes and altered interactions with long-term human and avian cohabitants are also mentioned. Changes such as these may be related to senility but also may be related to pain, discomfort, or musculoskeletal instability.

RECOGNIZING AND TREATING CHRONIC PAIN

Discussion of the frequency of various geriatric conditions should address the pain or discomfort that these conditions may cause and the disease processes themselves.

Pain studies in birds are limited. Some work has been done with nonsteroidal antiinflammatory drugs (NSAIDs), but again species variation may exist. Meloxicam (Metacam) has been shown to be readily excreted and have antiinflammatory properties in vultures and chickens, respectively.^{9,10} Species variation has been demonstrated in the half-life of meloxicam, flunixin, and sodium salicylate in 5 nonpsittacine avian species.¹¹ Pharmacokinetics of meloxicam were performed in 1 study on psittacines, specifically ring-necked parakeets (*Psittacula krameri*).¹² Veterinary use of the NSAID diclofenac in South Asian cattle has resulted in a decrease in the number of 3 vulture species (*Gyps* spp). Vultures are exposed to diclofenac while scavenging on livestock treated with the drug shortly before death. Numerous studies have shown that diclofenac causes kidney damage, increased serum uric acid concentrations, visceral gout, and death, although meloxicam is well tolerated at comparable dosages.^{13–15} Ketoprofen caused renal tubular necrosis in 1 study when used with propofol for anesthesia in eiders.¹⁶ Flunixin meglumine (Banamine) and ketaprofen were found to be renal toxic in budgerigars.¹⁷

Dosages of any particular NSAID needed to achieve blood levels that are sufficient in people to block nociceptors may not be effective in any or all species of birds. The half-life of those NSAIDs tested in poultry has been only a few hours.¹⁰ However, NSAIDs tend to migrate to sites of inflammation and are highly protein bound. Because NSAIDs block arachadonic acid from binding with the cyclooxygenase (COX) enzyme, thereby preventing conversion to thromboxane B₂, measurements of thromboxane levels may be a better assay for duration of NSAID activity. In at least 1 study, ketoprofen and flunixin administration suppressed thromboxane levels for up to 12 hours in budgerigars (*Melopsittacus undulatus*).¹⁷

Work done with synthetic opioid comparisons in psittacines has demonstrated that κ -opioid agonists such as butorphanol (Torbutrol) are superior to the μ agonists such as buprenorphine (Buprenex), although 1 study in chickens demonstrated isoflurane-sparing effects of both opioid types.^{18,19} Medications such as tramadol are being used empirically in birds, but the dosage needed to affect analgesia is not known. Tramadol

is a synthetic opioid that seems to have activity at the μ -opioid receptors and the noradrenergic and serotonergic systems. Therefore, the subjective efficacy of tramadol, if proven valid, may be caused by the later mechanisms. The duration of tramadol plasma levels, which in humans would affect analgesia, were considerably longer than butorphanol.²⁰

The pharmacokinetics of butorphanol in raptors has shown that the half-life is much shorter than in mammals, and more frequent dosing must be used to maintain blood levels.²¹ There was also variation in the rate of metabolism between raptor species, so caution should be used in extrapolation to psittacines. Additional work by Paul-Murphy¹⁸ has demonstrated significant differences among psittacine species in dosages of butorphanol required to reach levels that provide analgesia.

Recent work with liposome-encapsulated butorphanol tartrate (LEBT) has demonstrated in Hispaniolan Amazons the potential for prolonged pain relief of up to 5 days.²² For chronic pain in birds, this could be a valuable therapeutic option.

One study demonstrated that fentanyl (Duragesic) in cockatoos (*Cacatua alba*) was not effective unless used at what the investigators considered a prohibitively (by volume and potential side effects) high dosage.²³

Gabapentin has not been studied in birds, but its use in people and animals has shown promise. Anecdotal reports in psittacines indicate potential usefulness, especially with neuropathic pain. Studies in humans have shown variable results when gabapentin is combined with other analgesics. Most studies have demonstrated that combining gabapentin with narcotics or opioids may be useful, but combination with NSAIDs (including meloxicam) did not have a synergistic affect.^{24–27}

DISEASE CONDITIONS BY SYSTEM

Special Senses: Vision, Hearing and Olfaction

Except for vision, few studies have been performed on the effects of aging on psittacine special senses. To determine the potential for aging changes to affect a particular sense significantly, the degree of development of that special sense in the bird must be determined.

Vision

Psittacines have greater visual acuity than do humans. Their range of visible light includes the ultraviolet (UV) spectrum. This UV light detection is likely involved in sexual displays, mate determination, and assessment of the ripeness of fruits. Vision loss is a life-threatening handicap in wild birds, but not necessarily in captive birds. Blind birds that have gradually lost their vision acclimate well if their caging is not altered.

Cataracts are a leading cause of blindness in older pet birds. Incipient cataracts can be easily missed without a careful ophthalmic examination. If cataract surgery is considered, an electroretinogram (ER) is advisable. Recent work with Hispaniolan Amazons has established some baselines for psittacine ER normal values.²⁸ Whether extracapsular extraction or phacoemulsification is preferable is controversial, and the decision should be left to the ophthalmologist performing the procedure. With either technique, the small size of the avian eye is the limiting factor. Anterior uveitis does not often occur post cataract surgery in birds, and therefore if the procedure is successful, the prognosis for restored vision is good.

Birds with monocular vision (which includes psittacines) when suffering vision loss in 1 eye tend to hold their heads so that their good eye is forward. Unilateral blindness and this prolonged positional compensation can cause scoliosis in these individuals.²⁹

Iris atrophy is a common aging change in older dogs and cats and is reported in psittacines. On examination, irregular pupil margins, strands of iris that span across

portions of the pupil, or holes in the stroma may be seen. Iris color change may also occur. Incomplete pupillary light reflexes are easier to detect in dogs and cats because of the absence of voluntary pupillary control, but decreased pupillary constriction may be subjectively noted in psittacines with iris atrophy. This constriction may cause light sensitivity and retinal damage.

Nuclear sclerosis (NS) occurs as an aging change in humans, dogs, cats, psittacines, and most other species of vertebrate. The nucleus of the lens becomes increasingly dense as fibers are sequentially produced and the central fibers are compressed. When the pupil is dilated, the nucleus seems gray and homogeneous. Vision affectation in animals is not generally significant. As with dogs and cats, it may be difficult without indirect ophthalmologic examination for veterinarians to differentiate NS from a cataract, and examination by an ophthalmologist is recommended. When vision loss is present but only NS is detected, retinal disease is likely.

Retinal degeneration can occur as a result of nutritional, congenital, traumatic, or viral conditions. Genetic retinal disease has been identified in commercial poultry flocks, and produced experimentally. No genetic retinal disease has yet been identified in psittacines. In people, age-related retinal (macular) degeneration occurs in 2 forms. The dry form is the most prevalent (90%) form in people. The wet form, however, accounts for most impairment of vision in humans. Birds have no true macula and age-related degeneration of the fovea has not been reported in the literature, but may occur. Darkening of the fovea in older psittacines has been reported by ophthalmologists (McNabb N and Karpinski LG, Florida, personal communication, 2009).

Pituitary tumors have been documented in birds that have presented with blindness as the primary clinical sign. These tumors are generally space-occupying adenomas (see section on Neoplastic Diseases).^{30,31}

Atherosclerosis is a common condition in older pet psittacines and is discussed separately in the section on the cardiovascular system. Birds are sometimes noted to be functionally blind following an acute neurologic “episode” that causes impairment of the central nervous system, including blindness. At post mortem, these birds may have evidence of atherosclerotic plaques. In people, atherothrombotic stroke is the most common type of stroke. Size and equipment constraints currently prohibit accurate antemortem diagnosis of atherosclerosis or atherosclerotic stroke in birds.

Examination of the eyes of geriatric birds by an ophthalmologist often reveals subclinical disease. In the past 5 years, with in-house access to veterinary ophthalmologists, the following additional ocular diseases have been detected in this author’s practice when a geriatric avian patient presented for a possible cataract or an annual examination: keratoconjunctivitis sicca, corneal ulceration, acquired third eyelid abnormalities, hypopyon, anterior uveitis, conjunctival granulomas, and infectious diseases involving the conjunctiva, Harderian gland adenoma, and lymphoma.

Glaucoma does occur in birds, although diagnosis in psittacines is difficult because of the size of the cornea. Most reports of normal intraocular pressures, and increased intraocular pressures indicating glaucoma, are from larger raptor species.³²

Hearing

The hearing ability of psittacines differs from that of humans, but cannot be categorized simply as better or worse. Birds can distinguish frequencies in some ranges more accurately than can humans. These ranges are usually comparable to the range in which normal vocalizations of their species occur. However, the ability of birds to differentiate between intensities of sound or (with the exception of nocturnal predators) to localize the origin of sound is on average inferior to that of humans.

Birds may not have age-related hearing loss as is commonly seen in people. In humans, much hearing loss associated with aging is caused by loss of function of hair cells. In birds, these hair cells are able to regenerate.^{33,34}

Olfaction

Historically, it was believed that birds had poor olfactory ability. Evidence involving the olfactory receptors and olfactory bulb in multiple species of birds has shown that there is a higher percentage of functional olfactory receptors in birds compared with mammals, correlating with an increased olfactory bulb capacity.^{35–37} Pelagic birds and some species of vulture have specific but highly developed senses of smell. Further research is needed, but it seems that the sense of smell is more highly developed in at least some psittacine bird species, including the galah (*Eolophus roseicapillus*) and the kakapo (*Strigops habroptilus*), than was assumed previously.^{36,37}

It is not known whether decreased olfactory acuity occurs in birds as they age. If it does, as with decreased visual acuity, the geriatric bird could be limited in identification of food and recognition of familiar people, birds, and objects.

Musculoskeletal

Arthritis

There are few published reports of osteoarthritic changes that have been documented radiographically in pet birds. However, limitations of range of motion in our older psittacine birds are commonly noted in practice.

In attempting to identify causes and treatments for osteoarthritis in people, mammalian models have not demonstrated the development of this condition with sufficient frequency to be useful. Studies of avian skeletons from museum collections have demonstrated that birds show an incidence of osteoarthritis similar to that of people.³⁸ An inverse relationship between the body weight of birds and the incidence of osteoarthritis has also been documented.³⁹

Why the discrepancy between osteoarthritis documented in pet birds and the incidence that is reported in clinical practice? First, older birds are often sedentary, and abnormalities of gait are not so obvious as they are in quadruped dogs and cats. The amount of bony proliferation that accompanies arthritis in birds may also be less than that seen in mammals, particularly dogs, in which severe hip arthritis and degenerative joint disease are readily apparent on radiographs. It has been shown that osteomyelitis in birds produces less bony proliferation than is produced in mammals.⁴⁰ In addition to a less proliferative response, pet birds are smaller and therefore details of the joints are difficult to visualize with routine radiography. The hock (tibiotarsal/tarsometatarsal) joint and the stifle seem to be the most affected,²³ although coxofemoral joint range-of-motion limitations are commonly noted in older birds. Moreover, tendon calcification has been noted on histopathology of birds.⁴¹ Tendon calcification may cause the same clinical presentation as arthritis in birds, without prominent radiographic findings.

The weight of the bird, its general physical condition, previous injuries, and any concurrent medical conditions can all contribute to the onset and severity of arthritis. Pododermatitis is often present, likely a cause and a result of decreased activity. Arthritis in 1 leg often leads to pododermatitis on the contralateral foot. Malnutrition, which decreases the integrity of the plantar epithelium, and concurrent obesity are often noted in affected birds. The cage environment, especially the variety, diameter, and texture of perches, can be important in providing comfort and stability for arthritic birds, and preventing or minimizing pododermatitis. Severely arthritic birds may need a padded platform or perch to maintain their balance. Ease of food and water access

should be ensured. If the feet and nails are anatomically and positionally normal, the nails should be left with sharp points to add strength and stability to the grip. Wings should not be excessively clipped, so they can be used to help maintain balance. In addition to adjustments in the enclosure, NSAIDs such as meloxicam are being used in birds to decrease inflammation and discomfort.

Articular gout

Articular gout occurs most commonly in older psittacine birds. The onset is often acute, and increased plasma uric acid level usually accompanies the clinical presentation.

Uric acid accumulates in the joint capsules and tendon sheaths of the joints. The metatarsophalangeal or interphalangeal joints are generally affected, and typically exhibit white to light-yellow swellings that seem grossly similar to abscesses. These uric acid deposits are painful in most birds. The cause in psittacines is generally underlying renal pathology. Treatment is discussed in the section on renal disease.

Osteoporosis

Among the causes of osteoporosis are increased phosphorus intake, calcium and vitamin D₃ deficiencies, and reduced physical activity. Deficiencies are often seen in adult female birds that are reproductively active. In older birds of either sex, osteoporosis from prolonged poor diet and inactivity is common. All seed diets provide excessive dietary phosphorus leading to insufficient calcium absorption. Radiographs may suggest osteopenia. Plasma calcium, ionized calcium, and vitamin D (specifically 25-hydroxycholecalciferol) plasma levels aid in determining appropriate therapy. Research has shown that all bird species tested to date benefit from and use oral and UV-B delivered vitamin D₃; however, African gray parrots (*Psittacus erithacus*) have a greater dependence on UV-B light for maintaining adequate serum calcium levels than do *Amazona* spp.⁴²

Gastrointestinal (see Neoplastic Diseases)

Except for neoplastic disease, few conditions of the avian gastrointestinal (GI) tract have been associated with aging. Chronic vitamin A deficiency leads to squamous metaplasia along the length of the upper GI tract. Ulceration of the mucosa of the proventriculus and ventriculus can occur. These lesions may be associated with foreign bodies, known disease-causing organisms, opportunistic organisms, or no identifiable infectious or mechanical agent. Birds that have intermittent regurgitation and anorexia, and a decreased GI transit time noted on a barium series, may clinically improve when treated with H₂ blockers or proton pump inhibitors. The underlying cause or causes of GI ulceration in many cases are unknown.

Cloacal disease in older birds

Intermittent cloacal bleeding in older birds is often caused by cloacal masses including papillomatosis, benign masses and polyps, and neoplastic conditions (see sections on Reproductive and Neoplastic Diseases).

Hepatic

Hepatic lipidosis is most common in obese birds on a diet that contains excess fat and is deficient in biotin, choline, and methionine. Excessive fat intake leads to lipid accumulation in hepatocytes. Mild lipidosis may be reversed. Severe and long-standing hepatic lipidosis creates a cycle of hepatocellular damage, fibrosis, and cirrhosis.

Chronic liver disease is a common finding in older birds. Causes have not been documented for psittacines, but the history often includes obesity (and therefore

potential hepatic lipidosis), probable exposure to mycotoxins, and deficiencies in vitamin A and certain amino acids. Bile acid increase is often present, with or without concurrent increases in hepatic enzymes. Serial hepatic biopsies of these birds demonstrate a progression from fibrosis to cirrhosis, with an increasing percentage of involved hepatocytes (Reavill DR, personal communication, 2008).

When the bird is no longer anorexic, dietary change is critical. Medical therapy may delay the progression of chronic liver disease to end-stage hepatic fibrosis. The efficacy of antifibrotic medication in birds is poorly documented and most is extrapolated from either human or canine/feline medicine. One mainstay of mammalian antiinflammatory therapy is corticosteroids. The risk versus benefit ratio of glucocorticoids for this use in birds has not been established.

Colchicine is used in birds as an antiinflammatory agent for articular gout and to prevent hepatic fibrosis. Numerous studies have been performed in laboratory rats that demonstrate the ability of colchicine to limit hepatic fibrosis.⁴³ Although there is no documentation of the efficacy of colchicine in birds, anecdotal reports suggest that it may reduce fibrosis.

Ursodeoxycholic acid (UDCA) (Ursodiol, Actigall) therapy may be beneficial in the treatment of birds with liver disease, especially those with bile acid increases. Birds produce cholic, allocholic, and chenodeoxycholic acids, which can produce hepatocellular lysis. UDCA may replace these bile acids and promote bile excretion. This drug is the first-line treatment for humans with biliary cirrhosis. Its immune-modulating effects may also be beneficial in hepatic inflammatory conditions. Again, dosages are extrapolated from human or small mammal medicine and efficacy is unproven.

HEPATIC NEOPLASIA (SEE NEOPLASTIC DISEASES)

Renal

Renal disease is present in a high percentage of birds at necropsy, and has few noninvasive definitive tests available ante mortem. Uric acid increase can indicate renal disease, but can also be a function of diet or contamination. Normal uric acid levels do not exclude renal functional impairment.

Obtaining and interpreting a urinalysis is difficult because of fecal comingling in the cloaca and the lack of a urinary bladder. The presence of proteinuria in birds may be a result of fecal contamination. Conversely, the absence of proteinuria may be caused by the absence of proteolytic enzymes in avian leukocytes, so that protein-losing nephropathy may not occur in avian glomerular disease.⁴⁴

Older birds on a lifelong deficient diet may have an adverse reaction when suddenly placed on a balanced pelleted diet. This reaction may be noted as polyuria/polydipsia (PU/PD) or general malaise, with possible increase of plasma uric acid levels. One theory for this occurrence is that the renal (and often hepatic) parenchyma is reduced in function because of chronic deficiencies in vitamin A precursors and amino acids (lysine, methionine, and cysteine, among others). This parenchyma seems to be most common in cockatiels. These birds may already have compromised renal function caused by chronic malnutrition (ie, squamous metaplasia of the tubules and collecting ducts of the kidney from chronic vitamin A deficiency may cause renal tubular disease). The desquamated metaplastic squamous epithelial cells can obstruct urinary production and flow. Change to a pelleted diet that contains higher, albeit "normal" levels of protein, may overload their compromised renal and hepatic capacities. Therefore, caution should be used in improving the diet of geriatric birds, even when plasma chemistries are normal. Often, the gradual addition of a quality pelleted diet with close observation of the bird's fecal and urinary output, attitude,

and weight, allow the owner and veterinarian to determine whether a complete or partial conversion to a pelleted diet can be achieved in a geriatric avian patient.

Renal biopsy is the best method of determining the presence, type, and extent of renal disease. Histopathologic diagnoses of nephrosis (urate or other), bacterial nephritis, glomerulopathy, or fibrosis, all change the treatment of the bird and its prognosis. A renal biopsy obtained endoscopically on a stable avian patient by a practitioner experienced in this technique carries a minimal risk.⁴⁴ If renal biopsy is not possible, older birds presenting for PU/PD, nonspecific clinical signs of lethargy, with normal blood glucose levels, increased or “high normal” fasting uric acid levels, mild anemia, and a persistent heterophilia may warrant treatment of renal disease.

Treatment of the various conditions of the kidney that may be determined via biopsy have been published elsewhere.⁴⁴ Pending biopsy results, antibiotics are warranted for potential bacterial nephritis. In most cases, omega-3 fatty acids are valuable and have been shown to decrease inflammation and increase renal vascular flow and glomerular filtration rates.⁴⁵ The use of antiinflammatory agents such as aspirin, colchicine, allopurinol, and probenecid may be considered. The use of aggressive fluid therapy initially and long-term diuresis may be an important part of treatment in psittacine renal disease, depending on the cause of the disease and the response of the bird to the fluid therapy.

The feasibility of continued fluids at home must take into account the owner's willingness and the temperament of the bird. In 1 ongoing case, this author's practice has monitored a Goffin cockatoo (*Cacatua goffini*) with renal nephrosis, after initial hospitalization and diagnostics, for more than 18 months while it has received at-home administration of subcutaneous fluids (and omega-3 fatty acids and a low protein pelleted diet). In this individual (and not uncommonly in this genus of psittacine) the bird is complacent for the treatment and forgiving following treatment. For most species of the genera *Amazona* and *Ara*, unless the owner is unusually adept at administration, the outlook for fluid therapy administered by the owner yet maintaining the owner-pet bond is less positive (see section on Administration of Medications).

Treatment of articular gout may be unrewarding. Colchicine and allopurinol are used as antiinflammatory agents. Aggressive fluid therapy may be attempted, and dietary supplementation with omega-3 fatty acids and vitamin A precursors. Probenecid usage is controversial in avian gout.⁴⁶ Pain relief may be attempted by frequent administration of butorphanol. It is to be hoped that, with further research, the long-acting liposome-encapsulated butorphanol will continue to demonstrate a long half-life in the avian system of various species and become commercially available. Caution should be used in prescribing NSAIDs in these birds because of the potential for renal compromise. Because of the pain displayed by birds with uncontrolled articular gout, if pain cannot be controlled, euthanasia should be considered.

Endocrine

Reports of endocrine diseases in older birds other than neoplasia are not common. An adrenal syndrome of vacuolation of the interrenal cells (the equivalent of the mammalian adrenal cortical cells) is seen in African gray parrots (*Psittacus erithacus*), often resulting in sudden death.³⁰

Pancreatic islet cell hyperplasia has been noted occasionally on histopathology. The A cells (which secrete glucagon) are most often affected. If there is a correlation with hyperglycemia in psittacines, it has not been documented; clinical signs reported with necropsy submissions for histopathology have been vague.

Hyperglycemia (avian diabetes mellitus) is not uncommon in mature, obese birds and in females that have had prolonged hyperestrogenism. Moderately increased

glucose levels (700–800 mg/dL or 40 mmol/L) may be transient hyperglycemia and not representative of a primary diabetes mellitus.

Hypertrophy of the parathyroid glands is noted in birds that chronically consume a diet insufficient in calcium. These birds may also demonstrate bony lesions at necropsy.⁴¹

Nonneoplastic diseases of the thyroid gland in psittacines are poorly understood. Autoimmune thyroiditis has been documented in poultry but not in psittacines. Degenerative thyroid lesions are reported occasionally on histopathology, but the cause is unknown. The incidence of hypothyroidism in psittacines is also unknown, likely because of the historical lack of availability of thyroid-stimulating hormone for testing.

Cardiovascular

As birds live longer and diagnostics improve, a greater incidence of avian cardiac disease is being detected. Cardiac disease can still be difficult to diagnose and may mimic other conditions, such as respiratory, hepatic, or ovarian disease. The bird may present in a weak or lethargic condition or with increased respiratory rate and effort. With right-sided heart disease, hepatomegaly and ascites are common. Disease may also be subclinical, then present acutely, and the bird may expire when diagnostics or treatment are attempted. Right heart disease is more prevalent in birds than left-sided cardiac disease, as discussed later.

Pulmonary hypertension

The avian cardiovascular system differs anatomically and physiologically from the mammalian in several parameters. The physiologic responses that maintain low pulmonary vascular resistance in mammals (vascular distensibility and vasculature recruitment) are absent in birds,⁴⁷ which results in the inability of the pulmonary vasculature to accommodate increased cardiac output by either altering vessel diameter or changing the percentage of vasculature channels being used. This result is, at least in part, responsible for the high incidence of pulmonary hypertension syndrome (PHS) in the poultry industry and right-sided heart disease in psittacine patients.

Because of the financial impact of PHS in broiler hens, much research has been conducted in this area. In addition to the lack of vascular accommodation in avian species as noted earlier, studies have demonstrated that the response to pulmonary arterial hypertension in chickens is an increase in 2 vasoactive substances, the vasodilator nitric oxide (NO) and the vasoconstrictor serotonin 5-hydroxytryptamine (5-HT); the vasoconstrictor 5-HT predominates over the vasodilator NO in broiler hens susceptible to PHS.⁴⁸ For the broiler industry, genetic selection of hens is being investigated. For geriatric psittacine patients, this would indicate that specific vasodilator therapy in cases of pulmonary hypertension might be of value and warrants further research. The avian anatomy makes visualizing the pulmonary artery and vein via echocardiology difficult.⁴⁹ Also, even if indirect measurements of avian systemic blood pressure (BP) become reliable to obtain, they do not directly correlate with pulmonary pressures.

Although it is a subjective parameter, birds whose jugular veins become extremely distended when gently occluded for venipuncture are often the same patients (commonly African gray parrots [*Psittacus erithacus*]) that have the signalment for pulmonary hypertension and atherosclerosis. The use of angiotensin-converting enzyme (ACE) inhibitors such as enalapril (Enacard) and benazepril (Lotensin) and inodilators such as pimobendan (Vetmedin) may be considered in these patients, with the caveats of unproven efficacy and unknown risk.

Macaw asthma

Macaw asthma, or macaw polycythemia, may theoretically cause pulmonary hypertension, from chronic air capillary hypoxia and subsequent polycythemia. No published data on pulmonary hypertension in macaws diagnosed with this syndrome were located.

Renal shunt and cardiovascular disease

Another potential cause of cardiac disease in birds is the existence of the renal portal shunt, which allows bacteria from the lower GI tract to enter the general circulation without filtration by the liver.⁵⁰ This increased chance of bacterial sepsis may lead to a higher incidence of valvular and thromboembolic disease.

Epicardial and myocardial fat

In chronically obese birds, epicardial fat and infiltration of fat into the myocardium is seen at necropsy. The clinical history of these birds often includes sudden death, with no other significant findings on gross or histopathologic examination.⁵¹

Atherosclerosis

Atherosclerosis is common in psittacine birds. It is generally a geriatric condition,⁵² with the exception of African gray parrots (*Psittacus erithacus*), in which this disease has been noted with some frequency in younger animals. The most common sign is sudden death; in people, coronary, carotid artery, and peripheral vascular occlusions from atherosclerosis are often not diagnosed until the conditions are well advanced. Without the ability to perform cardiac catheterization and concurrent measurement of vessel diameters, antemortem diagnosis in psittacines is unlikely.⁵³ Other diagnostic modalities including duplex ultrasound, magnetic resonance imaging, and angiography are generally cost and size prohibitive in psittacine birds.

Clinical signs may include dyspnea, lethargy, paresis, blindness, ataxia, or collapse. Tentative diagnosis is based on:

1. Increased risk factors such as age, species, obesity, dietary history, and inactivity
2. Blood work findings that include lipemic serum, increased plasma cholesterol levels, increased triglycerides, increased low-density lipoproteins (LDLs) and decreased high-density lipoproteins (HDLs)
3. Chronic egg-laying birds with estrogen-induced lipemia (note: in the avian liver, estrogen causes the conversion of carbohydrate to triglyceride and the production of proteins involved in the production of triglyceride-rich lipoprotein particles, leading to hypersecretion of these lipoproteins into the circulation⁵⁴)
4. Clinical signs such as episodic dyspnea, lethargy, paresis, blindness, ataxia, or collapse
5. Radiographic evidence of calcification and widening of the greater vessels, most commonly the right aortic arch, or cardiomegaly.

These clinical and laboratory findings are anecdotal or extrapolated from human medicine. Definitive research in causation, diagnosis, and treatment of atherosclerosis in psittacines is lacking. In birds, atherosclerosis most commonly affects the aorta and brachiocephalic trunks. The coronary arteries are less often affected; therefore ischemia of the myocardium is uncommon. Numerous cases of atherosclerosis in psittacines have been published.^{55–60}

As in people, weight loss, increased activity, and dietary regulation are all in line with improvement of overall health and presumed preventative measures against atherosclerotic plaques. In some cases, practitioners may elect to institute therapy with lipid-lowering medications such as statins. No dosages are available for birds, nor

are any given in this article, but extrapolation from human medicine (accounting for the higher metabolism of birds) is being used for dosing. Anecdotal reports, including patients from this author's practice, have had significant reductions in cholesterol and triglycerides that did not occur with diet change alone. No adverse affects have been noted in the limited cases available. Nor can it be stated definitively that these drugs have been effective in preventing atherosclerosis. One study has shown that ginseng is effective in lowering plasma cholesterol levels in birds.⁶¹

Echocardiology

The response to the stress of handling can increase heart rate and oxygen demand significantly in birds; therefore, inhalant anesthesia is preferred to manual restraint for performance of echocardiograms in all but the most docile patients. Equipment recommendations include an ultrasound unit with Doppler function, 100 frames/s minimum speed and microcurved or phased array probes with minimum 7.5 MHz frequency. Anatomic constraints in birds also limit the echocardiographic windows available. Parameters for chamber sizes, blood flow velocities, functional contractility, and valvular insufficiency have been determined for several species and studies are ongoing.⁴² In birds with decreased myocardial contractility and reduced fractional shortening, anecdotal reports of a positive response to enalapril are common. When right-sided cardiac insufficiency and ascites are present, furosemide has been clinically useful in treatment.

The avian veterinarian is advised to work in conjunction with a cardiologist on avian patients with suspected cardiac disease. Diagnosis of the cardiovascular abnormality and formulation of a therapeutic plan require knowledge of avian anatomy and physiology and the cardiologist's diagnostic skills and pharmacologic recommendations. Although most avian therapeutic regimes are still extrapolated from mammalian regimes, numerous reports indicate that cardiac drug therapy can improve cardiac function, thereby increasing the quality and length of the life of the bird. Furosemide, enalapril, and pimobendin have all been used to treat avian cardiac disease. No controlled studies of the effects of these drugs are available.

Indirect BP measurements

In 1 study of 16 healthy Amazon parrots, no correlation was found between direct and indirect BP readings.⁶² Other practitioners have reported anecdotal correlation between BP and clinical signs of hypertension. BP measurements in psittacines would be valuable in treatment of septic shock, blood loss, cardiac disease, renal disease, and atherosclerosis, along with monitoring avian patients during anesthesia. However, until further studies are conducted that determine an accurate indirect method of measuring BP in psittacines, BP measurements should be at best considered as trends in the individual patient.⁶²

Arrhythmias

Second-degree atrioventricular (AV) block has been reported anecdotally and in a recent case report.⁶³ However, there has not been documentation in psittacines that cardiac arrhythmias are noted more commonly in older birds, nor of a physiologic trigger or pathologic cause. Whether arrhythmias are truly less common in psittacines than in mammals or more difficult to detect via auscultation and electrocardiogram (ECG) because of the rapid heart rate, is not known.

Reproductive

Decreased reproductive success has been noted with aging in all species tested. Although poultry studies predominate, in aging hens a decreased clutch number,

decreased frequency of clutches, and decreased viability of young have been documented in other birds such as swans and multiple zoologic species.⁵³

Cystic ovaries

The frequency of cystic ovarian disease in mature and aging psittacine hens is unknown. It has been reported anecdotally and by avian pathologists.⁶⁴ Tentative diagnosis is often via radiology or ultrasound. This condition may occur alone or in conjunction with other reproductive pathology, such as egg yolk peritonitis and ovarian neoplasia. Cystic ovarian disease may be asymptomatic, or present in various ways. Breeding behavior in the absence of egg laying, increased sternopubic distance, abdominal distention, and subsequent dyspnea from coelomic mass effect are possible clinical signs. Ovocentesis for relief of the space-occupying effect and for differentiation between cystic ovarian disease and infection may be accomplished with ultrasound guided aspiration. Leuprolide acetate (Depo-Lupron) has been used to stimulate follicular atresia. In many cases of documented cystic ovaries, the presence or absence of concurrent ovarian disease or neoplasia has not been determined.

Gonadotropin inhibitory hormone (GnIH) synthesis and GnIH receptors have been isolated in the avian reproductive system, including ovarian granulosa cells, along with the interstitial layer and seminiferous tubules of the testis in studies on 2 orders of birds: Passeriformes and Galliformes.⁶⁵ This mechanism may provide an alternate treatment of ovarian cysts and induce cessation of breeding behavior if the hormone becomes commercially available.

Egg yolk peritonitis, egg yolk stroke, and oviductal prolapse are reproductive diseases that may persist in older birds, but are primarily diseases of mature adult hens.

Neoplastic Diseases

Statistics on the rate of occurrence of various neoplasias in birds are usually obtained from the files of avian and exotic veterinary pathologists. Few practitioners or institutions have sufficient caseloads to develop meaningful statistics. The data published by pathologists are useful and would be made more so if practitioners who submit samples provided more extensive histories.

Xanthomas

Xanthomas are generally friable, yellow-colored fatty-appearing masses that may be located anywhere on the body, but are often seen on the distal wing, in the sternopubic area, and on the keel. The origin of xanthomas is unknown; however, dietary improvement, including sufficient vitamin A or vitamin A precursors, has been noted to be curative in less advanced cases.⁶⁶ Xanthomas tend to be vascular and surgical excision, when necessary, should be undertaken with due attention to hemostasis. Diffuse xanthomas may be amenable to cryotherapy, but attention must be paid to maintenance of the vascular supply.⁶⁷

Lipomas

Lipomas occur most frequently in budgerigars, but are also seen in *Amazona* spp, *Ara* spp, cockatiels (*Nymphicus hollandicus*), and other psittacines, and are often associated with excessive body fat. These masses are usually located on the keel or in the sternopubic area. Malignant liposarcomas are rare in psittacines.⁶⁸

In older psittacines, xanthomas and lipomas may become life threatening when they are present in the sternopubic area. Concurrent abdominal herniation is often present, and when combined with an extensive mass, may result in difficulty in evacuation of the cloaca, abrasion, hemorrhage, and infection. A combination of weight loss, altered

environment to prevent trauma to the area, and surgery may be required. The practitioner must bear in mind that these older birds often have hepatic lipidosis, decreased hepatic function, coagulopathies, and cardiovascular disease. Surgery, if necessary, should be as kept as noninvasive and as short duration as is possible.

If the bird is a good candidate for abdominal surgery, a GI contrast study or ultrasound should be performed to determine if bowel loops are present in the herniated sternopubic area before surgical intervention.

Fibrosarcomas

Fibrosarcomas can occur anywhere on the body, but are most commonly seen on the face, in the oral cavity, associated with long bones, or in the abdominal cavity. They tend to be locally invasive and often recur with conservative surgical excision. Local treatment with radiation therapy is often indicated for providing long-term control. The metastatic rate is low, so local disease management is paramount.⁶⁷ Surgical excision followed by radiation and chemotherapy has been reported with some success. Strontium radiation therapy, although limited by depth of penetration, has been anecdotally reported as efficacious in several instances.

Squamous cell carcinomas

Squamous cell carcinomas (SCC) may also occur anywhere on the body, being most prevalent at mucocutaneous junctions, in the oral cavity, in the infraorbital sinus, on the distal wing, the phalanges, and the uropygial gland.⁶⁹ SCC tend to be aggressively locally invasive, and complete excision is rarely accomplished. Radiation therapy has been attempted with some success; however, SCC seems to be an exceptionally radioresistant tumor and long-term control is rare. Anecdotal reports indicate that radioresistance may be greater in birds than in mammals. Strontium therapy when tumor depth is not a limiting factor has shown some promise in selected psittacine cases. Distant metastasis is rare; therefore systemic chemotherapy is not commonly used. Photodynamic therapy has been attempted in 2 reported cases. One case of SCC in the beak of a hornbill showed a positive result in decreasing tumor size but failure to eliminate the neoplasia.⁷⁰ Other case reports had equivocal results.⁷¹ Intraleisional cisplatin and intralesional cisplatin combined with cryosurgery have been effective in inducing partial remissions in 3 cases of oral and 1 case of submandibular SCC in psittacines in this author's practice. Species involved included a 26-year-old Congo African gray (*Psittacus erithacus*), an 8-year-old male *Eclectus* sp, a green wing macaw more than 30 years old (*Ara chloroptera*) and a 36-year-old Wagler's conure (*Aratinga wagleri*) (Maldonado, Lightfoot, Stevenson, unpublished data). Although to the author's knowledge, age-related data have not been collated, SCC seems to occur with greater frequency in geriatric psittacines. The constant necrosis caused by the SCC itself and by the chemo- and cryotherapies produce a fertile breeding ground for bacteria, yeast, and fungus. Appropriate antimicrobial therapy should be continued throughout the duration of treatment to avoid septicemia.

Melanomas

Melanomas are not common in birds, but are 1 of the few tumors in which distant metastasis is noted. Primary malignant melanoma has been diagnosed on the beak, in the liver, on the skin of the face, and in the oral cavity of psittacines. Metastatic melanoma lesions have been noted in the cardiac muscle, kidneys, and brain. Aggressive local invasion of a malignant melanoma was also seen in the sinus of an African gray parrot (*Psittacus erithacus*).⁷¹ Ages of birds involved have not been reported.

Musculoskeletal system

Chondroma, hemangioma, and malignant tumors including osteosarcoma, chondrosarcoma, and leiomyosarcoma have all been reported. Wide surgical resection or amputation are the suggested methods of treatment, as benign lesions are often cured with complete excision and a decrease in tumor burden can be accomplished in malignant lesions. Extrapolation from canine and feline oncology may suggest other modalities, such as radiation therapy for additional local treatment and chemotherapy for systemic control.⁶⁷

A biopsy should be obtained from patients in which radiographic bony lesions are present. Under inhalant anesthesia, a 23- to 20-gauge needle can be surgically introduced into the bone. A sufficient sample is usually obtained and subsequently retained in the hub of the needle. The sample can then be dislodged with smaller gauge wire and submitted.

Internal carcinomas

Ovarian neoplasias (various cell origins), renal carcinomas, hepatic adenocarcinoma, hepatobiliary and pancreatic adenocarcinoma, splenic, and gastric carcinomas have all been reported in older psittacines.

A few case reports and anecdotal reports exist indicating intralesional cisplatin or carboplatin therapy may be useful in ovarian and renal adenocarcinoma, generally following surgical debulking and confirmation of the neoplasia via histopathology.^{72,73} Bile duct carcinoma has also been treated with carboplatin successfully in 1 report.⁷⁴ Toxicity studies with cisplatin and carboplatin in cockatoos indicate that psittacine tolerance for these drugs may be greater than that of mammals.^{75,76}

Ovarian neoplasia

Similar to human ovarian adenocarcinoma, p53 tumor suppressor gene alterations are common in chicken ovarian adenocarcinomas and correlate with the number of lifetime ovulations.⁷⁷ Aspirin treatment may inhibit the progression of ovarian cancer in the hen.⁷⁸

Tamoxifen has been used for its antiestrogen effect in chicken ovaries in dozens of studies relating to human female reproduction. One study conducted in budgerigars demonstrated minimal side effects of tamoxifen administration, the main one being leucopenia. Although the study was designed to assess safety, the change in cere color of the hens from brown to blue implies that estrogen was inhibited.^{79–81} GnRH agonists have been effective empirically; however, confirmation of neoplasia (as opposed to cystic ovarian disease) has often not been obtained.

Gastric, biliary, hepatic, and pancreatic neoplasias

Gastric carcinomas can be seen in the esophagus and most commonly at the proventricular/ventricular junction. There is an apparent predilection for this neoplasia in *Amazonas* spp. and budgerigars (*Melopsittacus undulatus*).⁸² Diagnosis can be difficult, because they tend to be flat to ulcerative lesions (not proliferative). Radiographic GI contrast studies may demonstrate an irregular mucosa and suggest a neoplastic process. Isthmus carcinomas can ulcerate through the serosa, causing coelomitis.

Biliary and pancreatic carcinomas are frequently diagnosed in the genus *Amazona* and to a lesser degree *Ara* in conjunction with internal papillomatosis.⁸³ The herpes virus of Pacheco disease has been identified in birds with internal papillomatosis. The genotype of the herpes virus and the species of bird contribute to susceptibility to acute Pacheco disease or the development of internal papillomatosis.⁸⁴

Reports of various tumors in the liver of birds include hepatocellular carcinoma, cholangiocarcinoma, lipoma, sarcoma, hemangioma/sarcoma, and adenocarcinoma.

Carboplatin has been used in several cases with equivocal results, but with no apparent toxicity. Tumors that metastasize to the liver are uncommon, but include lymphoma and pancreatic carcinoma. The reported incidence of primary hepatocellular carcinoma is low in Old World species.

Endocrine neoplasias

Pituitary adenomas have been documented in multiple avian species but are most prevalent in budgerigars and cockatiels.⁶⁷ Affected animals may present with acute neurologic conditions (seizures/opisthotonos/blindness). They may also present with conditions related to the pituitary hormones that are affected. Usually, this is pronounced polydipsia and polyuria. Occasional presentations are of a retrobulbar mass and subsequent exophthalmia. In human medicine, surgical resection and radiation therapy (if needed) are used for treatment. Size and monetary constraints make routine treatment by these methods unlikely in small psittacine patients.

Lymphoma/Lymphosarcoma

Lymphoma may have many presentations in older pet birds, including lymphatic, hemopoietic, hepatic, and cutaneous lymphoma. The incidence of oral lymphosarcoma in *Amazona* spp and retrobulbar or periorbital presentations in Congo African grays (*Psittacus erithacus*) is overrepresented.⁸⁵ Chemotherapy is the treatment of choice for systemic disease. Surgery and radiation therapies have been successfully employed in cases of solitary lymphoma. To date, no evidence of retroviral activity has been associated with psittacine lymphoma.^{67,85}

Respiratory Neoplasia

Primary respiratory neoplasia is uncommon in psittacines. An exception seems to be an intrathoracic neoplasia reported in cockatiels (*Nymphicus hollandicus*). It is characterized by the inclusion of 2 cell types, having mesenchymal and epithelial cell components.⁸⁶ Few other primary pulmonary neoplasias have been reported in the literature. Metastatic pulmonary neoplasia may occur, but it is not noted with the same frequency as is documented in dogs.^{67,87,88}

Note Regarding Treatment of Psittacine Neoplasia

The presentation of anecdotal treatments in the literature is problematic. Preliminary information regarding clinical response may expand the practitioner's ability to attempt treatment. However, future studies may either reinforce these protocols, or demonstrate a lack of efficacy or serious side effects.

For localized tumors, when surgical excision is incomplete or impossible, alternative forms of therapy, including external beam radiation (cobalt 60 or linear accelerator), cryotherapy, photodynamic therapy, or hand-held radiation applicators bear consideration.

Rapid advances in treatment recommendations warrant a current literature search before making recommendations for therapy. Consultation with other avian veterinarians and veterinary oncologists is advisable.

ADMINISTRATION OF MEDICATION AND QUALITY OF LIFE

Many geriatric conditions discussed in this article require long-term medication. In many if not most birds, direct oral administration is a stressful event for the bird and the owner. Helping the owner to find alternatives (the most common being admixing the medication in a favorite soft food) can greatly enhance compliance and quality of life. Ideally, owners should find a favorite soft food that is given occasionally as

a treat before the need for medication. The importance of this quality of life issue is often overlooked in practice.

THE GERIATRIC ANNUAL EXAMINATION

As the pet psittacine population ages, practitioners are developing long-standing relationships with the individual bird and its owner. An annual office visit and physical examination offer an opportunity to prevent overt disease processes by correcting husbandry issues and detecting early warning signs of disease. Record keeping that includes the condition of the plumage, of the plantar epithelium of the feet, grip strength, and response of the cardiovascular and respiratory systems to restraint can be as useful as laboratory tests. Minimally, these visits should include:

- a. A candid discussion with the owner regarding quality of life, encompassing changes in behavior that could be manifestations of pain, nervousness, fear, or disorientation such as the extent of vocalization, play, and movement within the bird's environment, and interaction with objects, other birds and people, compared with previous years
- b. Questions designed to detect incipient disease, such as changes in water consumption or urinary output, changes in food preferences or eating habits, reproductive and sexual behaviors, alterations in preening habits, changes of preferred perching locations, sleep cycle alterations
- c. A thorough physical examination that includes the routine physical examination and assessment of weight, muscle mass, grip strength, joint range of motion, ambulation, flight if applicable, feather condition, and exercise tolerance
- d. Radiographs to evaluate bone density, arthritic changes, cardiovascular abnormalities, organomegaly and to screen for coelomic masses
- e. Complete blood count and plasma chemistries, including bile acids, triglycerides, cholesterol, and HDL and LDL levels if indicated
- f. Ophthalmic examination
- g. Echocardiogram and ECG if warranted.

MEDICATIONS MENTIONED IN THE TEXT

Pharmacodynamic and kinetic studies have not been completed on most medications in the following list. Those drugs preceded by a single asterisk contain studies mentioned within the body of the article. However, none have the strength of evidence to qualify for the levels of grade A (randomized controlled trials and meta-analyses) or B (other evidence such as well-designed controlled and uncontrolled studies) for multiple psittacine species.

Judicious extrapolation needs to be made from diagnostics and treatments found effective in other species. Anecdotal experiences and information should be shared with owners and colleagues to best serve current patients and to give direction to future research.

Despite the tens of thousands of psittacines imported into the United States from the 1960s to the 1980s, there is little information on geriatric parrots. Most of these parrots are dead. It is to be hoped that improvements in nutrition and husbandry will change this situation and avian veterinarians will have increasing numbers of geriatric patients. Thoughtful alterations to the aging bird's environment can increase the quality of life of geriatric psittacines when mobility is compromised or vision impaired.

Drug	Dosage	Indications	Comments
*Meloxicam	0.5–1.0 mg/kg IV, PO every 12–24 h	Pain, inflammation, SCC	Occasional GI upset
*Butorphanol tartrate	1–3 mg/kg IV, PO every 2–6 h	Pain, sedation, reduction of inhalant anesthetic level. Higher range for Amazons	Short half-life (1–2 h) in species tested. PO may not reach adequate blood levels.
*LEBT	NA to date	Patent pending, may be effective for up to 5 days	May last up to 5 days
*Buprenorphine	0.05–1.0 mg/kg every 6–12 h	Pain sedation, reduction of inhalant anesthetic	In chickens; efficacy still questionable in other species
*Tramadol	5 mg/kg IV or PO every 6–24 h	Pain, sedation	Limited research in birds
*Fentanyl	0.02–0.2 mg/kg SC (see Comments)**	Analgesia; not currently recommended	**Low doses ineffective; higher doses have potential complications
Colchicine	0.01–2.0 mg/kg PO every 12–24 h	Hyperuricemia, hepatic or renal inflammation or fibrosis	Note wide empirical dosage range and potential to increase uric acid levels noted in some raptors
Allopurinol	10 mg/kg PO every 24 h	Hyperuricemia	Narrow range between efficacy and toxicity in hawks
Ursodeoxycholic acid	10–15 mg/kg PO every 24 h	Biliary stasis, increased bile acids	Subjective efficacy in reducing bile acid levels
Leuprolide acetate (Depo-Lupron)	200–800 µg/kg IM every 4 weeks prn	Cystic ovarian disease, excessive egg laying, estrogen dependent ovarian neoplasia?	No controlled studies; extensive empirical reports of efficacy but dosage range subjective
Enalapril	0.25–1.0 mg/kg every 24–48 h	Cardiomyopathy	ACE inhibitor
Furosemide	0.5–2.0 mg/kg every 6–24 h	Diuretic	Species sensitivities, including lorries
Pimobendin	0.1–1.0 mg/kg every 12–24 h	Pulmonary arterial dilator, cardiomyopathy	Atherosclerosis, only anecdotal reports
Atropine	0.01–0.05 mg/kg every 6–12 h	Bronchodilator, anticholinesterase	
Atropine	0.2–0.5 mg/kg	Bradycardia, cardiopulmonary resuscitation	
<i>Abbreviations:</i> IM, intramuscularly; IV, intravenously; NA, not applicable; PO, by mouth; prn, as required; SC, subcutaneously.			

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